

RST – Scientific report regarding the implementation of the "NATivE – Potential climate chaNge mediated recovery of AuTochthonous broadleaf species to the detrIment of allochthonous planted conifErs" project (code: PN-III-P1-1.1-PD-2016-0583; Financing Contract for Project Execution NO. 41 / 2018) within the 01/01/2020 – 30/06/2020 period

I. INTRODUCTION – THE SCIENTIFIC CONTEXT

Climate change (i.e., more frequent, more intense, and more severe drought events; IPCC 2013) has the capacity to cause tree decline and mortality (Allen et al., 2010; Allen et al., 2015; Hartmann et al. 2018) affecting thus the ecosystem services provided by forests (i.e., climate change mitigation, timber production, social services, etc.; Pan et al. 2011; Bonan 2016). In addition to the severe droughts associated with climate change, management measures also have the ability to determine the composition of forests because certain management measures such as plantation can favor certain tree species (i.e., non-native species for example) to the detriment of others (i.e., native species for example). The composition of forests (i.e., tree species) is therefore critical in understanding why certain tree species seem to be more affected (i.e., decline and mortality) by climate change than others. In this respect, variables such as the current situation of forests (i.e., native species vs. non-native species), their structure (plantations vs. natural forests), or the genetic predisposition of different tree species are key factors that should be considered for a better understanding of the future of our forests.

In Romania, according to the last National Forest Inventory (IFN, 2018), forests occupy approximately 7 million ha. Although Romania's climate is temperate-continental, climate models estimate that temperatures will rise by up to 2-3 Celsius degrees while the rainfall regime is likely to fall by up to 10% by the end of the XXI century here, so droughts represent a real threat for these regions (Collins et al. 2013). The effects of severe droughts associated with climate change are already being felt, important events of tree decline and mortality being already observed in Romania, where different species have been affected (Barbu and Popa 2001; Curiel Yuste et al. 2019; Sidor et al. 2019; Hereş et al. *under review*). Specifically, conifer species such as *Pinus sylvestris* L. (Scots pine) and *Pinus nigra* Arn. (Black pine) seem to be among the most affected ones, at least in regions such as Braşov (Photo 1, A.-M. Hereş; Curiel Yuste et al. 2019), while deciduous species such as *Fagus sylvatica* L. (European

beech) and *Quercus petraea* Matt. Liebl. (sessile oak) do not seem to suffer much in this regard. One of the main differences between the four species mentioned above is that the Scots pine and Black pine were planted outside their natural distribution range, while European beech and sessile oak are native species that grow naturally in the vicinity of the city of Braşov.



Photo 1 – Scots pine affected by decline and mortality in the vicinity of the city of Braşov (*photo: Ana-Maria Hereş*)

II. THE OBJECTIVES OF THE NATIVe PROJECT

Through the NATIVe project, it is proposed to study, using dendrochronological methods (i.e., annual tree-rings) and field inventories, both the historical growth of planted non-native tree species (Scots pine and Black pine) and native tree species (European beech and sessile oak), as well as the secondary succession of forests (i.e., regeneration) and competition, in forests located in the Braşov region that have been affected by mortality among conifers (i.e., Scots pine and Black pine).

The specific objectives of the NATIVe project are therefore: *i*). to analyze the historical growth of the planted non-native conifer species (Scots pine and Black pine) in comparison with that of the naturally present native deciduous trees (sessile oak and European beech); *ii*). to study the different strategies used by non-native planted species (Scots pine and Black pine) and by the naturally present ones (sessile oak and European beech) to cope with droughts, and the ability of these tree species to recover after they

have been facing severe droughts; and *iii*). to evaluate the regeneration success of the planted non-native conifer species (Scots pine and Black pine) compared to that of the naturally present native deciduous trees (sessile oak and European beech).

The objectives of the II stage (01/01/2020 – 30/06/2020): Study of regeneration processes in forests affected by tree mortality

Activity 3.1: Carrying out statistical analyzes and writing articles in order to publish them in specialized ISI journals, an activity that continues from stage II.

Activity 3.2: Dissemination (international conference) of the final results of the NATIVe project.

III. REZULTATE NATIVe

During the third stage, the activities statistical analysis of data and dissemination of results were continued. In this sense, the statistical analysis on deciduous species (i.e., European beech and sessile oak) was completed. More specifically, the growth data obtained from the measurement of annual tree-rings were analyzed. These data were used to see how these two species have grown over time and how they behave when dealing with severe droughts. The results of this study were used to make a master's thesis. This thesis was written by Petrea Ștefan under the guidance of dr. Hereș Ana-Maria (project director of NATIVe) and dr. Petritan Ion Catalin (professor of Transilvania University of Brașov). The results of this study showed that both European beech and sessile oak registered significant positive growth trends. In addition, both species are resilient to severe drought events, although they have different strategies in this regard. Specifically, the European beech is adapted to withstand severe droughts without significantly reducing its growth when dealing with such events (Figure 1). On the other hand, the sessile oak, even if during severe droughts it is forced to significantly reduce its growth, it then manages to return to the level of pre-drought growths, its recovery being achieved in a period of maximum two years after the severe drought events (Figure 1). The results of this study indicate that the two native deciduous species (i.e., European beech and sessile oak) have the ability to successfully cope with drought events, being thus also better adapted to cope with climate change than the non-native species of planted conifers (i.e., Scots pine and Black pine).

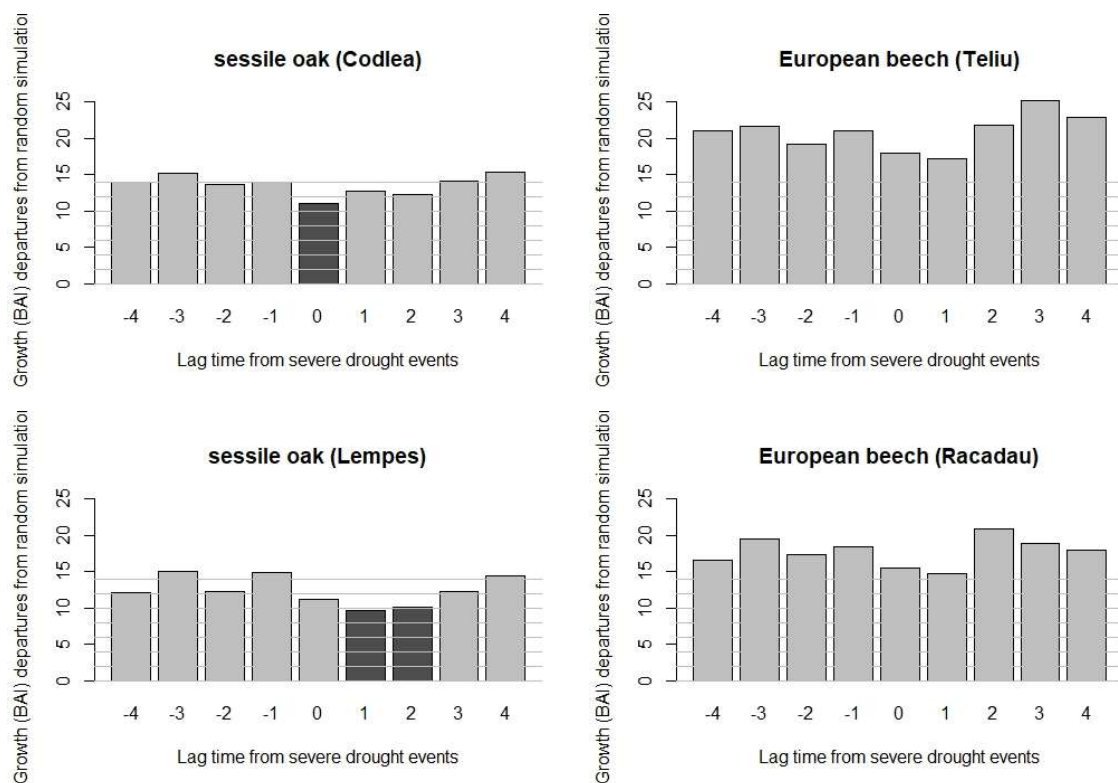


Figure 1 – Results of SEA (Superposed Epoch Analyses) analyses: growth (BAI = basal area increment) departures from the mean considering a series of events: four years before severe drought events (-4, -3, -2, -1), during severe drought events (0; 1976, 1987, 2002, 2012), and after severe drought events (1, 2, 3, 4). Different colours indicate non-significant (grey) or significant (black) growth departures considering random simulations (*figure: Petrea Ștefan; master thesis*)

In parallel with Petrea Ștefan's master's thesis, work began on an article in which the two species of conifers (i.e., Scots pine and Black pine) will be directly compared with the two species of deciduous trees (i.e., European beech and sessile oak) (Hereș et al. *in prep*). This article will analyze the growth (Figure 2) of the four species taking into account severe droughts and the management measures to which these species have been subjected to along time. Preliminary results indicate that deciduous species are indeed more resilient to drought than the two coniferous species. It should be noted that such studies are not common and that management measures, which have contributed to the current structure of forests and are therefore critical to better understand the

processes of decline and mortality, are often ignored. The effect of environmental factors such as climate (i.e., severe droughts) on trees and therefore forests must be studied and understood taking into account important aspects, such as management measures, which can be decisive in terms of how trees respond to stressful conditions. The NATivE project therefore fills a knowledge gap and brings important information about how different species may or may not successfully cope with severe drought events depending on their native or non-native status.

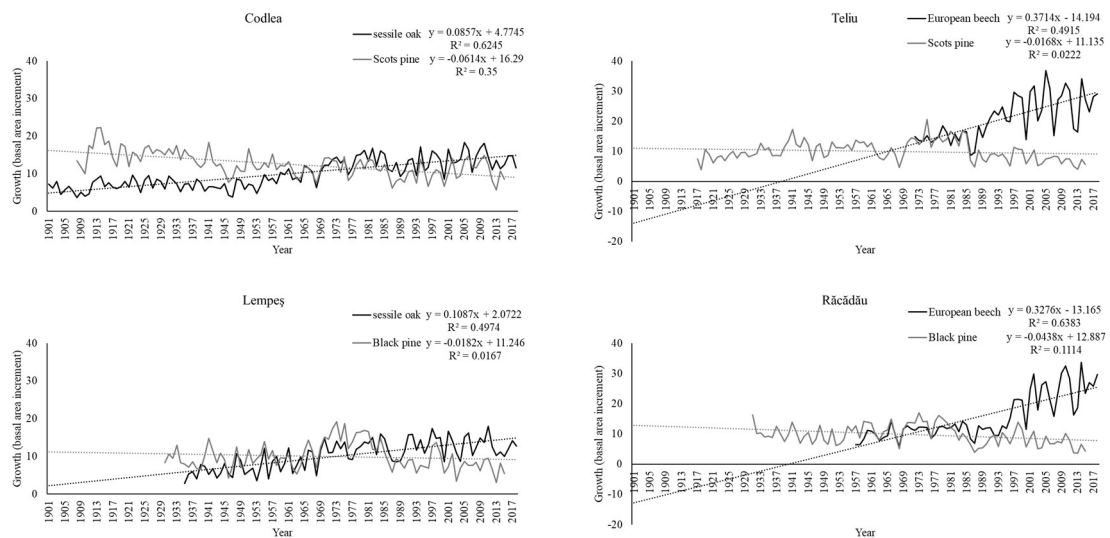


Figure 2 – Growth (basal area increment) trends of the four studied species (Scots pine, Black pine, European beech, and sessile oak) (Hereş et al. *in prep.*)

The results obtained in 2020 should have been presented at the Mixed Forests conference that would have taken place in Lund (Sweden) between 25-27 March 2020. At this conference the project director should have presented a poster entitled "*Mixed forests of allochthonous conifer and native broadleaf species from central Romania (Brasov)*". However, this was not possible due to the situation caused by the COVID-19 virus which affected the whole world.

The management of the project:

In 2020, it was not necessary to purchase new materials or equipment because in this last stage only statistical analyzes were performed, manuscripts were written in order to publish ISI articles and Petrea Ştefan's master's thesis was written. Therefore, all the activities corresponding to this stage were performed on the computer, with no need to

travel in the field. In addition, the computer activity is justified by the situation generated by the COVID-19 virus which has restricted any kind of movement both within the country and outside it. As such, the conference planned for the dissemination of the results of the NATivE project was also canceled (Mixed Forests, Lund, Sweden).

IV. CONCLUSIONS

The activities (3.1 and 3.2) proposed for the stage III of the NATivE project were successfully completed during 2020, according to the working plan. Statistical analyses were performed and manuscripts were written in order to be sent to specialized ISI journals for publication. In addition to these manuscripts, within the NATivE project, a master's thesis was written by Petrea Ștefan entitled "*Native sessile oak and European beech species are able to cope with severe drought events*" and supervised by dr. Hereș Ana-Maria (project director NATivE) and dr. Petritan Ion Catalin (professor at the Transilvania University of Brasov). Activity 3.2 was eventually impossible to perform due to the situation generated by the COVID-19 virus. It should be mentioned that the project director had been accepted at this conference where she would have presented a poster ("*Mixed forests of allochthonous conifer and native broadleaf species from central Romania (Brasov)*").

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